

may be exceeded by one or two of the take-off, flyover, or approach calculated noise levels determined under section H36.203 of this appendix if

- (1) The sum of the exceedances is not greater than 4 EPNdB;
- (2) No exceedance is greater than 3 EPNdB; and
- (3) The exceedances are completely offset by reduction in the other required calculated noise levels.

[Amdt. 36-14, 53 FR 3541, Feb. 5, 1988; 53 FR 4099, Feb. 11, 1988; 53 FR 7728, Mar. 10, 1988, as amended by Amdt. 36-54, 67 FR 45237, July 8, 2002; Amdt. 36-25, 69 FR 31234, June 2, 2004; Amdt. 36-25, 69 FR 41573, July 9, 2004]

#### APPENDIX I TO PART 36 [RESERVED]

#### APPENDIX J TO PART 36—ALTERNATIVE NOISE CERTIFICATION PROCEDURE FOR HELICOPTERS UNDER SUBPART H HAVING A MAXIMUM CERTIFICATED TAKEOFF WEIGHT OF NOT MORE THAN 7,000 POUNDS

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##### PART A—REFERENCE CONDITIONS

###### Section J36.1 *General.*

This appendix prescribes the alternative noise certification requirements identified under § 36.1 of this part and subpart H of this part for helicopters in the primary, normal,

transport, and restricted categories having maximum certificated takeoff weight of not more than 7,000 pounds including:

(a) The conditions under which an alternative noise certification test under subpart H of this part must be conducted and the alternative measurement procedure that must be used under § 36.801 of this part to measure the helicopter noise during the test;

(b) The alternative procedures which must be used under § 36.803 of this part to correct the measured data to the reference conditions and to calculate the noise evaluation quantity designated as Sound Exposure Level (SEL); and

(c) The noise limits for which compliance must be shown under § 36.805 of this part.

###### Section J36.3 *Reference Test Conditions.*

(a) *Meteorological conditions.* The following are the noise certification reference atmospheric conditions which shall be assumed to exist from the surface to the helicopter altitude:

(1) Sea level pressure of 2116 pounds per square foot (76 centimeters mercury);

(2) Ambient temperature of 77 degrees Fahrenheit (25 degrees Celsius);

(3) Relative humidity of 70 percent; and

(4) Zero wind.

(b) *Reference test site.* The reference test site is flat and without line-of-sight obstructions across the flight path that encompasses the 10 dB down points of the A-weighted time history.

(c) *Level flyover reference profile.* The reference flyover profile is a level flight, 492 feet (150 meters) above ground level as measured at the noise measuring station. The reference flyover profile has a linear flight track and passes directly over the noise monitoring station. Airspeed is stabilized at  $0.9V_H$ ;  $0.9V_{NE}$ ;  $0.45V_H + 65$  kts (120 km/h); or  $0.45V_{NE} + 65$  kts (120 km/h), whichever of the four airspeeds is least, and maintained throughout the measured portion of the flyover. Rotor speed is stabilized at the maximum normal operating RPM throughout the 10 dB-down time interval.

(1) For noise certification purposes,  $V_H$  is defined as the airspeed in level flight obtained using the minimum specification engine power corresponding to maximum continuous power available for sea level pressure of 2,116 psf (1,013.25 hPa) at 77 °F (25 °C) ambient conditions at the relevant maximum certificated weight. The value of  $V_H$  and  $V_{NE}$  used for noise certification must be included in the Flight Manual.

(2)  $V_{NE}$  is the never-exceed airspeed.

(d) The weight of the helicopter shall be the maximum takeoff weight at which noise certification is requested.

*Section J36.5 [Reserved]*PART B—NOISE MEASUREMENT PROCEDURE  
UNDER § 36.801*Section J36.101 Noise certification test and measurement conditions.*

(a) *General.* This section prescribes the conditions under which helicopter noise certification tests must be conducted and the measurement procedures that must be used to measure helicopter noise during each test.

(b) *Test site requirements.* (1) The noise measuring station must be surrounded by terrain having no excessive sound absorption characteristics, such as might be caused by thick, matted, or tall grass, shrubs, or wooded areas.

(2) During the period when the flyover noise measurement is within 10 dB of the maximum A-weighted sound level, no obstruction that significantly influences the sound field from the helicopter may exist within a conical space above the noise measuring position (the point on the ground vertically below the microphone), the cone is defined by an axis normal to the ground and by half-angle 80 degrees from this axis.

(c) *Weather restrictions.* The test must be conducted under the following atmospheric conditions:

(1) No rain or other precipitation;

(2) Ambient air temperature between 36 degrees and 95 degrees Fahrenheit (2 degrees and 35 degrees Celsius), inclusively, and relative humidity between 20 percent and 95 percent inclusively, except that testing may not take place where combinations of temperature and relative humidity result in a rate of atmospheric attenuation greater than 10 dB per 100 meters (30.5 dB per 1000 ft) in the one-third octave band centered at 8 kilohertz.

(3) Wind velocity that does not exceed 10 knots (19 km/h) and a crosswind component that does not exceed 5 knots (9 km/h). The wind shall be determined using a continuous averaging process of no greater than 30 seconds;

(4) Measurements of ambient temperature, relative humidity, wind speed, and wind direction must be made between 4 feet (1.2 meters) and 33 feet (10 meters) above the ground. Unless otherwise approved by the FAA, ambient temperature and relative humidity must be measured at the same height above the ground.

(5) No anomalous wind conditions (including turbulence) or other anomalous meteorological conditions that will significantly affect the noise level of the helicopter when the noise is recorded at the noise measuring station; and

(6) If the measurement site is within 6560 feet (2,000 meters) of a fixed meteorological station (such as those found at airports or other facilities) the weather measurements

reported for temperature, relative humidity and wind velocity may be used, if approved by the FAA.

(d) *Helicopter testing procedures.* (1) The helicopter testing procedures and noise measurements must be conducted and processed in a manner which yields the noise evaluation measure designated Sound Exposure Level (SEL) as defined in section J36.109(b) of this appendix.

(2) The helicopter height relative to the noise measurement point sufficient to make corrections required under section J36.205 of this appendix must be determined by an FAA-approved method that is independent of normal flight instrumentation, such as radar tracking, theodolite triangulation, laser trajectory photography, or photographic scaling techniques.

(3) If an applicant demonstrates that the design characteristics of the helicopter would prevent flight from being conducted in accordance with the reference test conditions prescribed under section J36.3 of this appendix, then with FAA approval, the reference test conditions used under this appendix may vary from the standard reference test conditions, but only to the extent demanded by those design characteristics which make compliance with the reference test conditions impossible.

*Section J36.103 [Reserved]**Section J36.105 Flyover test conditions.*

(a) This section prescribes the flight test conditions and allowable random deviations for flyover noise tests conducted under this appendix.

(b) A test series must consist of at least six flights. The number of level flights made with a headwind component must be equal to the number of level flights made with a tailwind component over the noise measurement station:

(1) In level flight and in cruise configuration;

(2) At a height of 492 feet  $\pm$ 50 feet (150  $\pm$ 15 meters) above the ground level at the noise measuring station; and

(3) Within  $\pm$ 10 degrees from the zenith.

(c) Each flyover noise test must be conducted:

(1) At the reference airspeed specified in section J36.3(c) of this appendix, with such airspeed adjusted as necessary to produce the same advancing blade tip Mach number as associated with the reference conditions;

(i) Advancing blade tip Mach number ( $M_{AT}$ ) is defined as the ratio of the arithmetic sum of blade tip rotational speed ( $V_R$ ) and the helicopter true air speed ( $V_T$ ) over the speed of sound (c) at 77 degrees Fahrenheit (1135.6 ft/sec or 346.13 m/sec) such that  $M_{AT} = (V_R + V_T)/c$ ; and

(ii) The airspeed shall not vary from the adjusted reference airspeed by more than  $\pm$ 3

knots ( $\pm 5$  km/hr) or an equivalent FAA-approved variation from the reference advancing blade tip Mach number. The adjusted reference airspeed shall be maintained throughout the measured portion of the flyover.

(2) At rotor speed stabilized at the power on maximum normal operating rotor RPM ( $\pm 1$  percent); and

(3) With the power stabilized during the period when the measured helicopter noise level is within 10 dB of the maximum A-weighted sound level ( $L_{AMAX}$ ).

(d) The helicopter test weight for each flyover test must be within plus 5 percent or minus 10 percent of the maximum takeoff weight for which certification under this part is requested.

(e) The requirements of paragraph (b)(2) of this section notwithstanding, flyovers at an FAA-approved lower height may be used and the results adjusted to the reference measurement point by an FAA-approved method if the ambient noise in the test area, measured in accordance with the requirements prescribed in section J36.109 of this appendix, is found to be within 15 dB(A) of the maximum A-weighted helicopter noise level ( $L_{AMAX}$ ) measured at the noise measurement station in accordance with section J36.109 of this appendix.

#### Section J36.107 [Reserved]

#### Section J36.109 Measurement of helicopter noise received on the ground.

(a) *General.* (1) The helicopter noise measured under this appendix for noise certification purposes must be obtained with FAA-approved acoustical equipment and measurement practices.

(2) Paragraph (b) of this section identifies and prescribes the specifications for the noise evaluation measurements required under this appendix. Paragraphs (c) and (d) of this section prescribe the required acoustical equipment specifications. Paragraphs (e) and (f) of this section prescribe the calibration and measurement procedures required under this appendix.

(b) *Noise unit definition.* (1) The value of sound exposure level (SEL), or as denoted by symbol,  $L_{AE}$ , is defined as the level, in decibels, of the time integral of squared 'A'-weighted sound pressure ( $P_A$ ) over a given time period or event, with reference to the square of the standard reference sound pressure ( $P_0$ ) of 20 micropascals and a reference duration of one second.

(2) This unit is defined by the expression:

$$L_{AE} = 10 \log_{10} \frac{1}{T_0} \int_{t_1}^{t_2} \left( \frac{P_A(t)}{P_0} \right)^2 dt \text{ dB}$$

Where  $T_0$  is the reference integration time of one second and  $(t_2 - t_1)$  is the integration time interval.

(3) The integral equation of paragraph (b)(2) of this section can also be expressed as:

$$L_{AE} = 10 \log_{10} \frac{1}{T_0} \int_{t_1}^{t_2} 10^{0.1 L_A(t)} dt \text{ dB}$$

Where  $L_A(t)$  is the time varying A-weighted sound level.

(4) The integration time  $(t_2 - t_1)$  in practice shall not be less than the time interval during which  $L_A(t)$  first rises to within 10 dB(A) of its maximum value ( $L_{AMAX}$ ) and last falls below 10 dB(A) of its maximum value.

(5) The SEL may be approximated by the following expression:

$$L_{AE} = L_{AMAX} + \langle \text{delta} \rangle A$$

where  $\langle \text{delta} \rangle A$  is the duration allowance given by:

$$\langle \text{delta} \rangle A = 10 \log_{10} (T)$$

where  $T = (t_2 - t_1)/2$  and  $L_{AMAX}$  is defined as the maximum level, in decibels, of the A-weighted sound pressure (slow response) with reference to the square of the standard reference sound pressure ( $P_0$ ).

(c) *Measurement system.* The acoustical measurement system must consist of FAA-approved equipment equivalent to the following:

(1) A microphone system with frequency response that is compatible with the measurement and analysis system accuracy prescribed in paragraph (d) of this section;

(2) Tripods or similar microphone mountings that minimize interference with the sound energy being measured;

(3) Recording and reproducing equipment with characteristics, frequency response, and dynamic range that are compatible with the response and accuracy requirements of paragraph (d) of this section; and

(4) The calibration and checking of measurement systems must use the procedures described in Section A36.3.9.

(d) *Sensing, recording, and reproducing equipment.* (1) The noise levels measured from helicopter flyovers under this appendix may be determined directly by an integrating sound level meter, or the A-weighted sound level time history may be written onto a graphic level recorder set at "slow" response from which the SEL value may be determined. With the approval of the FAA, the noise signal may be tape recorded for subsequent analysis.

(i) The SEL values from each flyover test may be directly determined from an integrating sound level meter complying with the Standards of the International Electrotechnical Commission (IEC) Publication No. 804, "Integrating-averaging Sound Level Meters," as incorporated by reference under

§36.6 of this part, for a Type 1 instrument set at “slow” response.

(ii) The acoustic signal from the helicopter, along with the calibration signals specified under paragraph (e) of this section and the background noise signal required under paragraph (f) of this section may be recorded on a magnetic tape recorder for subsequent analysis by an integrating sound level meter identified in paragraph (d)(1)(i) of this section. The record/playback system (including the audio tape) of the tape recorder must conform to the requirements prescribed in section A36.3.6 of appendix A of this part. The tape recorder shall comply with specifications of IEC Publication No. 561, “Electro-acoustical Measuring Equipment for Aircraft Noise Certification,” as incorporated by reference under §36.6 of this part.

(iii) The characteristics of the complete system shall comply with the recommendations given in IEC Publication No. 651, “Sound Level Meters,” as incorporated by reference under §36.6 of this part, with regard to the specifications concerning microphone, amplifier, and indicating instrument characteristics.

(iv) The response of the complete system to a sensibly plane progressive wave of constant amplitude shall lie within the tolerance limits specified in Table IV and Table V for Type 1 instruments in IEC Publication No. 651, “Sound Level Meters,” as incorporated by reference under §36.6 of this part, for weighting curve “A” over the frequency range of 45 Hz to 11500 Hz.

(v) A windscreen must be used with the microphone during each measurement of the helicopter flyover noise. Correction for any insertion loss produced by the windscreen, as a function of the frequency of the acoustic calibration required under paragraph (e) of this section, must be applied to the measured data and any correction applied must be reported.

(e) *Calibrations.* (1) If the helicopter acoustic signal is tape recorded for subsequent analysis, the measuring system and components of the recording system must be calibrated as prescribed under section A36.3.6 of appendix A of this part.

(2) If the helicopter acoustic signal is directly measured by an integrating sound level meter:

(i) The overall sensitivity of the measuring system shall be checked before and after the series of flyover tests and at intervals (not exceeding one-hour duration) during the flyover tests using an acoustic calibrator using sine wave noise generating a known sound pressure level at a known frequency.

(ii) The performance of equipment in the system will be considered satisfactory if, during each day’s testing, the variation in the calibration value does not exceed 0.5 dB. The SEL data collected during the flyover

tests shall be adjusted to account for any variation in the calibration value.

(iii) A performance calibration analysis of each piece of calibration equipment, including acoustic calibrators, reference microphones, and voltage insertion devices, must have been made during the six calendar months proceeding the beginning of the helicopter flyover series. Each calibration shall be traceable to the National Institute of Standards and Technology.

(f) *Noise measurement procedures.* (1) The microphone shall be of the pressure-sensitive capacitive type designed for nearly uniform grazing incidence response. The microphone shall be mounted with the center of the sensing element 4 feet (1.2 meters) above the local ground surface and shall be oriented for grazing incidence such that the sensing element, the diaphragm, is substantially in the plane defined by the nominal flight path of the helicopter and the noise measurement station.

(2) If a tape recorder is used, the frequency response of the electrical system must be determined at a level within 10 dB of the full-scale reading used during the test, utilizing pink or pseudorandom noise.

(3) The ambient noise, including both acoustical background and electrical noise of the measurement systems shall be determined in the test area and the system gain set at levels which will be used for helicopter noise measurements. If helicopter sound levels do not exceed the background sound levels by at least 15 dB(A), flyovers at an FAA-approved lower height may be used and the results adjusted to the reference measurement point by an FAA-approved method.

(4) If an integrating sound level meter is used to measure the helicopter noise, the instrument operator shall monitor the continuous A-weighted (slow response) noise levels throughout each flyover to ensure that the SEL integration process includes, at minimum, all of the noise signal between the maximum A-weighted sound level ( $L_{Amax}$ ) and the 10 dB down points in the flyover time history. The instrument operator shall note the actual db(A) levels at the start and stop of the SEL integration interval and document these levels along with the value of  $L_{Amax}$  and the integration interval (in seconds) for inclusion in the noise data submitted as part of the reporting requirements under section J36.111(b) of this appendix.

#### Section J36.111 Reporting Requirements.

(a) *General.* Data representing physical measurements, and corrections to measured data, including corrections to measurements for equipment response deviations, must be recorded in permanent form and appended to the record. Each correction is subject to FAA approval.

(b) *Data reporting.* After the completion of the test the following data must be included in the test report furnished to the FAA:

(1) Measured and corrected sound levels obtained with equipment conforming to the standards prescribed in section J36.109 of this appendix;

(2) The type of equipment used for measurement and analysis of all acoustic, aircraft performance and flight path, and meteorological data;

(3) The atmospheric environmental data required to demonstrate compliance with this appendix, measured throughout the test period;

(4) Conditions of local topography, ground cover, or events which may interfere with the sound recording;

(5) The following helicopter information:

(i) Type, model, and serial numbers, if any, of helicopter, engine(s) and rotor(s);

(ii) Gross dimensions of helicopter, location of engines, rotors, type of antitorque system, number of blades for each rotor, and reference operating conditions for each engine and rotor;

(iii) Any modifications of non-standard equipment likely to affect the noise characteristics of the helicopter;

(iv) Maximum takeoff weight for which certification under this appendix is requested;

(v) Aircraft configuration, including landing gear positions;

(vi)  $V_H$  or  $V_{NE}$  (whichever is less) and the adjusted reference airspeed;

(vii) Aircraft gross weight for each test run;

(viii) Indicated and true airspeed for each test run;

(ix) Ground speed, if measured, for each run;

(x) Helicopter engine performance as determined from aircraft instruments and manufacturer's data; and

(xi) Aircraft flight path above ground level, referenced to the elevation of the noise measurement station, in feet, determined by an FAA-approved method which is independent of normal flight instrumentation, such as radar tracking, theodolite triangulation, laser tractography, or photoscaling techniques; and

(6) Helicopter position and performance data required to make the adjustments prescribed under section J36.205 of this appendix and to demonstrate compliance with the performance and position restrictions prescribed under section J36.105 of this appendix must be recorded at an FAA-approved sampling rate.

#### *Section J36.113 [Reserved]*

### PART C—NOISE EVALUATION AND CALCULATIONS UNDER §36.803

#### *Section J36.201 Noise Evaluation in SEL.*

The noise evaluation measure shall be the sound exposure level (SEL) in units of dB(A) as prescribed under section J36.109(b) of this appendix. The SEL value for each flyover may be directly determined by use of an integrating sound level meter. Specifications for the integrating sound level meter and requirements governing the use of such instrumentation are prescribed under section J36.109 of this appendix.

#### *Section J36.203 Calculation of Noise Levels.*

(a) To demonstrate compliance with the noise level limits specified under section J36.305 of this appendix, the SEL noise levels from each valid flyover, corrected as necessary to reference conditions under section J36.205 of this appendix, must be arithmetically averaged to obtain a single SEL dB(A) mean value for the flyover series. No individual flyover run may be omitted from the averaging process, unless otherwise specified or approved by the FAA.

(b) The minimum sample size acceptable for the helicopter flyover certification measurements is six. The number of samples must be large enough to establish statistically a 90 percent confidence limit that does not exceed  $\pm 1.5$  dB(A).

(c) All data used and calculations performed under this section, including the calculated 90 percent confidence limits, must be documented and provided under the reporting requirements of section J36.111 of this appendix.

#### *Section J36.205 Detailed Data Correction Procedures.*

(a) When certification test conditions measured under part B of this appendix differ from the reference test conditions prescribed under section J36.3 of this appendix, appropriate adjustments shall be made to the measured noise data in accordance with the methods set out in paragraphs (b) and (c) of this section. At minimum, appropriate adjustments shall be made for off-reference altitude and for the difference between reference airspeed and adjusted reference airspeed.

(b) The adjustment for off-reference altitude may be approximated from:

$$\langle \Delta \rangle J_1 = 12.5 \log_{10} (H_T / 492) \text{ dB};$$

where  $\langle \Delta \rangle J_1$  is the quantity in decibels that must be algebraically added to the measured SEL noise level to correct for an off-reference flight path,  $H_T$  is the height, in feet, of the test helicopter when directly over the noise measurement point, and the constant (12.5) accounts for the effects on

spherical spreading and duration from the off-reference altitude.

(c) The adjustment for the difference between reference airspeed and adjusted reference airspeed is calculated from:

$$<\text{delta}>J_3 = 10 \log_{10}(V_{RA}/V_R) \text{ dB};$$

Where  $<\text{delta}>J_3$  is the quantity in decibels that must be algebraically added to the measured SEL noise level to correct for the influence of the adjustment of the reference airspeed on the duration of the measured flyover event as perceived at the noise measurement station,  $V_R$  is the reference airspeed as prescribed under section J36.3.(c) of this appendix, and  $V_{RA}$  is the adjusted reference airspeed as prescribed under section J36.105(c) of this appendix.

(d) No correction for source noise during the flyover other than the variation of source noise accounted for by the adjustment of the reference airspeed prescribed for under section J36.105(c) of this appendix need be applied.

(e) No correction for the difference between the reference ground speed and the actual ground speed need be applied.

(f) No correction for off-reference atmospheric attenuation need be applied.

(g) The SEL adjustments must be less than 2.0 dB(A) for differences between test and reference flight procedures prescribed under section J36.105 of this appendix unless a larger adjustment value is approved by the FAA.

(h) All data used and calculations performed under this section must be documented and provided under the reporting requirements specified under section J36.111 of this appendix.

#### PART D—NOISE LIMITS PROCEDURE UNDER § 36.805

##### *Section J36.301 Noise Measurement, Evaluation, and Calculation.*

Compliance with this part of this appendix must be shown with noise levels measured, evaluated, and calculated as prescribed under parts B and C of this appendix.

##### *Section J36.303 [Reserved]*

##### *Section J36.305 Noise Limits.*

For compliance with this appendix, the calculated noise levels of the helicopter, at the measuring point described in section J36.101 of this appendix, must be shown to not exceed the following (with appropriate interpolation between weights):

(a) For primary, normal, transport, and restricted category helicopters having a maximum certificated takeoff weight of not more than 7,000 pounds that are noise tested under this appendix, the Stage 2 noise limit is 82 decibels SEL for helicopters up to 1,737 pounds maximum certificated takeoff weight at which the noise certification is requested,

and increasing at a rate of 3.0 decibels per doubling of weight thereafter. The limit may be calculated by the equation:  $L_{AE}(\text{limit}) = 82 + 3.0 [\log_{10}(\text{MTOW}/1737)/\log_{10}(2)]$  dB, where MTOW is the maximum takeoff weight, in pounds, for which certification under this appendix is requested.

(b) The procedures required in this amendment shall be done in accordance with the International Electrotechnical Commission IEC Publication No. 804, entitled “Integrating-averaging Sound Level Meters,” First Edition, dated 1985. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies may be obtained from the Bureau Central de la Commission Electrotechnique Internationale, 1, rue de Varembe, Geneva, Switzerland or the American National Standard Institute, 1430 Broadway, New York City, New York 10018, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: [http://www.archives.gov/federal\\_register/code\\_of\\_federal\\_regulations/ibr\\_locations.html](http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html).

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## PART 39—AIRWORTHINESS DIRECTIVES

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